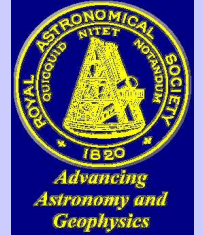




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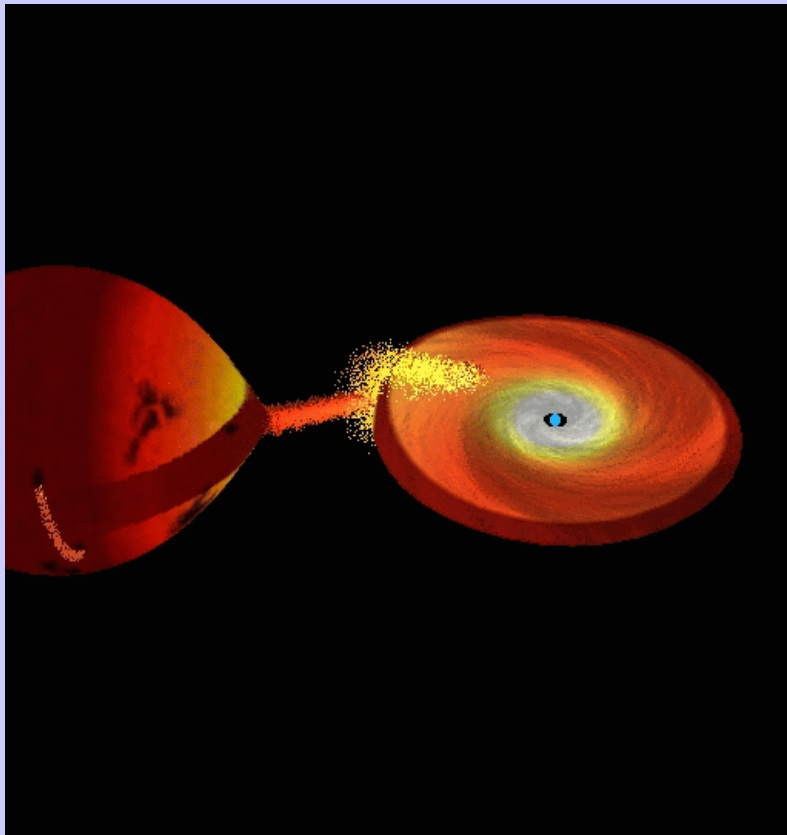
**Are there any implications for SuperAGB
stars from neon novae?**

Nye Evans
Keele University



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Nova eruptions occur in semi-detached binary systems containing a white dwarf primary and a cool (MS dwarf) secondary.

Orbital periods \sim 1-5 hr



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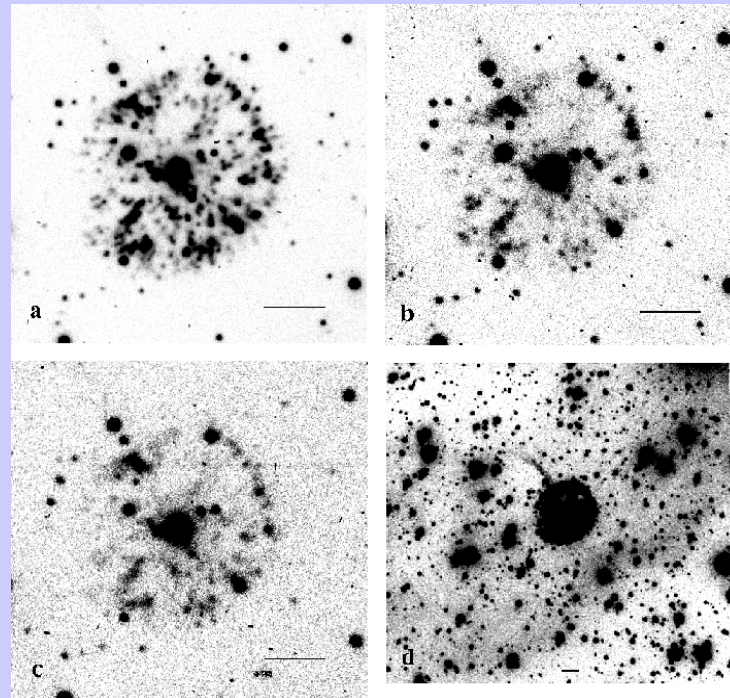
Precursors of nova systems must have the following properties:

- precursor primary must be massive enough to develop H- and/or He-exhausted core
- initial orbital separation large enough that this happens before primary fills Roche lobe
- initial orbital separation small enough, and mass ratio high enough, that when primary fills Roche lobe, a common envelope is formed
- mass of secondary \ll initial mass of primary, so most of mass injected by primary into common envelope is ejected

and all within a Hubble time

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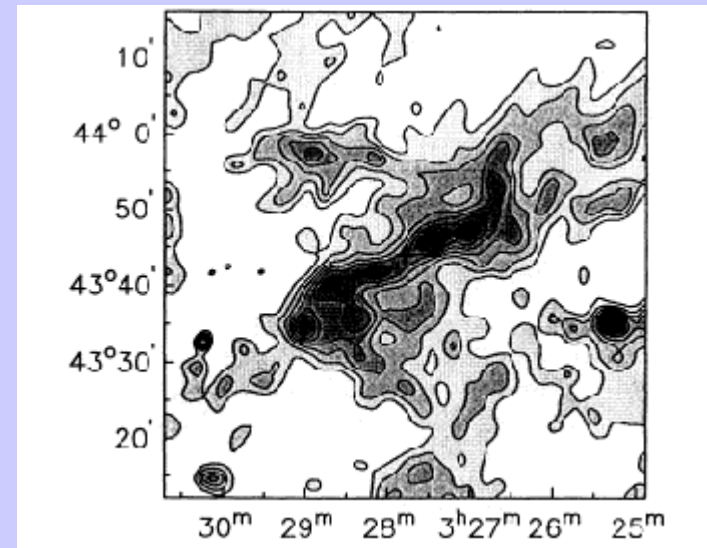
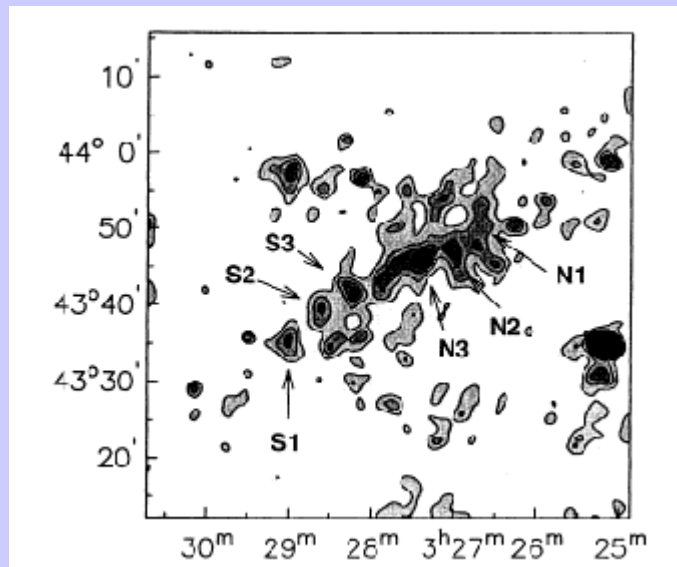


The remnant of GK Per (1901)

The optical view (Anupama & Kantharia, 2005, A&A, 435, 167)

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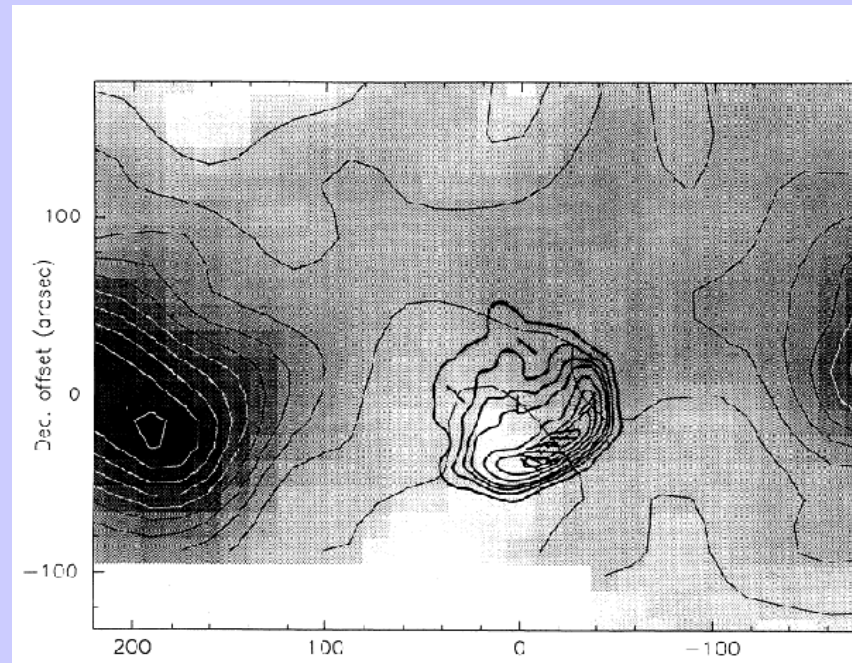
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“Planetary nebula” associated with GK Per (1901).
The IRAS view (Dougherty et al. 1996, A&A, 306, 574)

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Planetary nebula associated with GK Per (1901)
The CO view (Scott et al. 1994, MNRAS, 269, 707)



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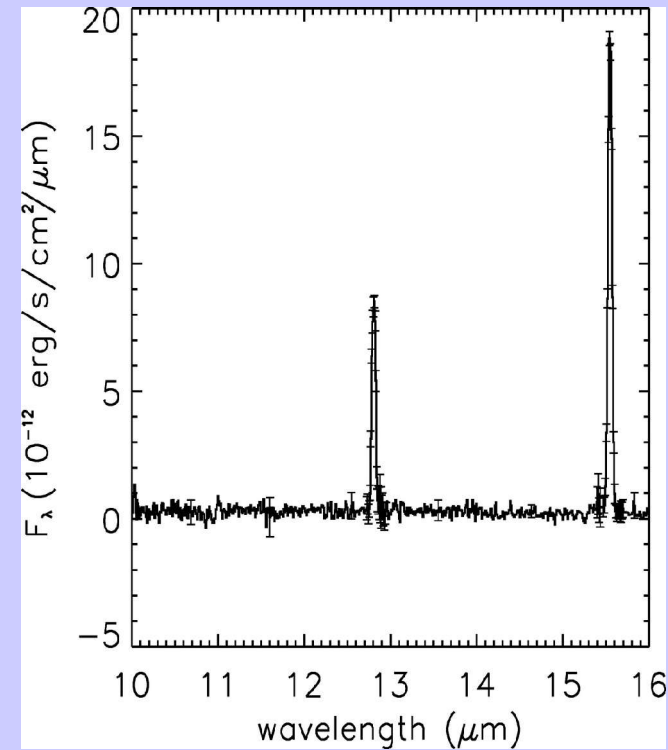
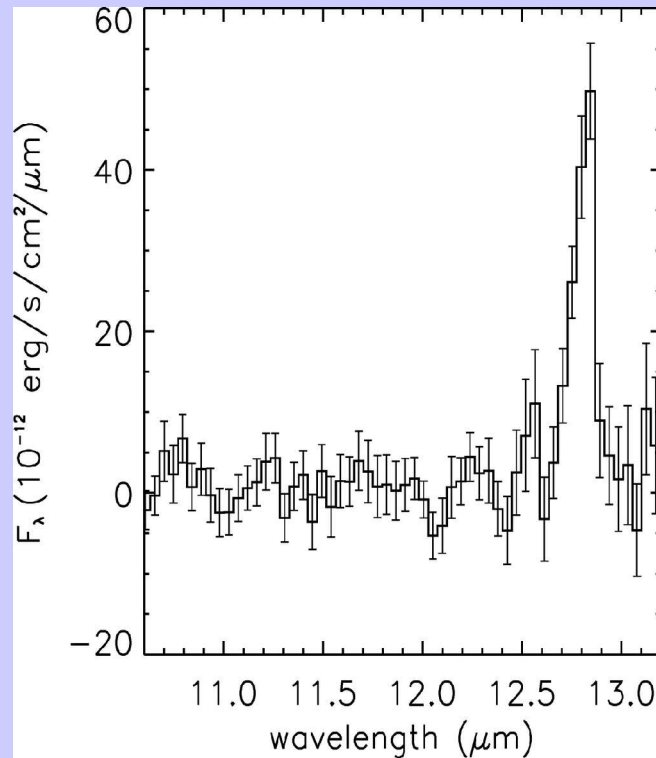


Nature of white dwarf can determine nature of nova:

- ONe WD ($M_{WD} > 1.2 M_{SUN}$)
 - > coronal (dust-free) nova
 - > signature: early appearance of [NeII]12.8 microns ----> **Neon novae**
- CO WD ----> dusty novae
- One-quarter of novae occur on WD with a strong ($\sim 10^6$ G, ~ 100 T) magnetic field

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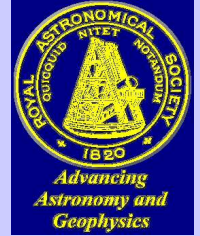
Spitzer IRS observations of [Ne] fine structure lines in nova QU Vul (1984).

From Gehrz et al., 2008, ApJ, 672, 1167



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Neon overabundances in novae (selection)

Nova	Year	H	He	C/N/O	Ne	Ne(Nova)/ Ne (Solar)	Ref
V1500 Cyg	1975	0.490	0.210	0.070/0.075/0.13	0.0230	13	Gehrz et al., 1998, PASP, 110, 3
V693 CrA	1981	0.290	0.320	0.046/0.080/0.12	0.1700	97	“ “ “
V1370 Aql	1982	0.053	0.088	0.035/0.088/0.035	0.5200	296	“ “ “
V1974 Cyg	1992	0.190	0.320	---/0.085/0.290	0.1100	68	“ “ “
QU Vul	1984	0.680	0.270	---/0.010/0.041		198	Gehrz et al., 2008, ApJ, 672, 1167
V842 Cen	1986	0.410	0.230	0.12/0.21/0.030	0.0038	0.51	Nova on CO WD



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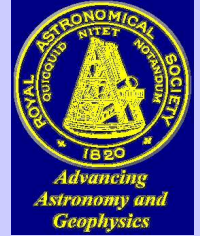


- Large abundances of Ne (and Al, Mg etc) in nova ejecta due to dredge-up of material from WD
- This means that the WD mass in nova systems is *decreasing*, so nova WDs are not evolving towards SNe



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- Stars with mass $< 10-12 M_{\text{SUN}}$ are expected to end up as either CO or ONe WD; critical mass separating CO/ONe WD will depend on details of stellar evolution, binarity of progenitor etc.
- ***As novae are binaries, and composition of WD determines composition of nova ejecta, potential for locating lower mass limit for ONe WDs***



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TABLE 1
CLASSICAL NOVA WHITE DWARF AND OUTBURST CHARACTERISTICS

M_{WD} (M_{\odot})	R_{WD} (cm)	M_{envl} (M_{\odot})	ϵ_b (ergs g ⁻¹)	E_b (ergs)	L_{Pacz} (L_{\odot})	L_{Edd} (L_{\odot})	\dot{M}_{nucl} (M_{\odot} yr ⁻¹)	τ_{nucl} (yr)	τ_{recur} (yr)	f
0.6	9.5 (8)	1.3 (-3)	8.4 (16)	2.2 (47)	4.62 (3)	2.28 (4)	6.44 (-8)	2.02 (4)	1.3 (6)	0.100
0.7	8.6 (8)	7.3 (-4)	1.1 (17)	1.6 (47)	1.05 (4)	2.66 (4)	1.47 (-7)	4.98 (3)	7.3 (5)	0.053
0.8	7.7 (8)	4.2 (-4)	1.4 (17)	1.2 (47)	1.64 (4)	3.04 (4)	2.29 (-7)	1.83 (3)	4.2 (5)	0.042
0.9	6.9 (8)	2.4 (-4)	1.7 (17)	8.4 (46)	2.24 (4)	3.42 (4)	3.13 (-7)	770	2.4 (5)	0.040
1.0	6.1 (8)	1.3 (-4)	2.2 (17)	5.7 (46)	2.83 (4)	3.80 (4)	3.95 (-7)	330	1.2 (5)	0.046
1.1	5.2 (8)	6.4 (-5)	2.8 (17)	3.6 (46)	3.42 (4)	4.18 (4)	4.77 (-7)	130	6.4 (4)	0.062
1.2	4.4 (8)	2.8 (-5)	3.6 (17)	2.1 (46)	4.02 (4)	4.56 (4)	5.61 (-7)	50	2.8 (4)	0.100
1.3	3.3 (8)	9.0 (-6)	5.3 (17)	9.4 (45)	4.61 (4)	4.94 (4)	6.43 (-7)	14	9.0 (3)	0.230
1.35	2.7 (8)	4.0 (-6)	6.7 (17)	5.3 (45)	4.91 (4)	5.13 (4)	6.85 (-7)	5.6	4.0 (3)	0.320

Relative frequency f of nova outbursts as fn of WD mass

Note high frequency for $M_{WD} > 1.2 M_{SUN}$

(Gehrz et al, 1998, PASP, 110, 3)



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- ♦ Selection effect: high frequency of observed nova explosions occur on ONe WD
- ♦ Mean (observed) mass of nova WD $\sim 1.1-1.2 M_{\text{SUN}}$, cf. mean mass of WD $\sim 0.6 M_{\text{SUN}}$



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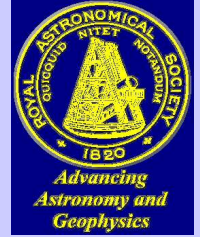
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- Neon Novae are likely an important source of Galactic ^{26}Al and ^{22}Na
- Determination of the distribution of Galactic ^{22}Na (lifetime 2.7yr) via 1275keV gamma-ray line emission may provide information about the distribution of Neon Nova progenitors



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Are there any implications for SuperAGB stars from neon novae?

- **Critical mass separating CO and ONe WD**
- **Magnetic field of progenitor**
- **Space distribution of SuperAGB stars**
- ***but only for SuperAGB stars in binaries...***



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